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REMOTELY CONTROLLED GYROSTABILIZED OPERATOR CRANE

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FIELD OF INVENTION

The invention relates to lifting machines, in particular to movie-operator crane which are arranged on various movable carriers: automobiles, ships, etc.

Prior Art

The closest solution in accordance with the technical subject matter is "REMOTELY CONTROLLED MOVIE-OPERATOR CRANE" (Inventor's Certificate of the U.S.S.R. No. 1,217,774) has a boom composed of telescopably connected movable and immovable sections, with the latter section hingedly mounted on a vertical support so as to vertically turn and connected with a vertical drive of the boom, wherein the vertical support is arranged on a base with the possibility of horizontal turning and connected to the drive of the horizontal turning, a first hinge link for arranging on it of a movie camera mounted on the movable section of the boom, a second and a third hinge link which form with the first hinge link and movable section a hinge-lever mechanism of a parallelogram type, wherein on a link which is parallel to the movable section the toothed rack is mounted cooperating with the drive of

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extension of the movable section and mounted with the possibility of the axial movement in a housing hingedly mounted on the vertical support eccentrically relative to the axis of the hinge of mounting of the immovable section on the vertical support, and in the housing there is a drive for extension of the movable section which is kinematically connected with a counterweight movably mounted in the tail part of the movable section of the boom, a control board, electronic blocks of vertical and horizontal turning of the boom.

The above described remotely controlled operator crane has the following disadvantages:

1. Vibration of parts of the carrier on which it is arranged, as well as gaps of the drive of the mechanisms of crane and other movements of its construction cause substantial angular and rectilinear vibrations of the movie shooting equipment, which negatively effects the quality of the image.

2. Construction of hinge-lever parallelogram-type mechanism makes complicated assembly, increases weight of the crane and does not provide a vertical position of the hinge link during inclinations, swings and accelerations of the carrier, which disturbs the horizontal position of the frame with the use of any panoramic head for installation of the camera.

3. Angular vibrations of the carrier are transmitted to the whole construction of the crane and cause increased load of the parts of the carrier, to which the crane is mounted, limit the possibility of the selection of the carrier and require reinforcement of its parts.

4. Rectilinear vibrations of the carriers are transmitted by the crane to the camera, which cause vibration of image even in the case of the use for shooting of gyrostabilized panoramic heads.

Summary of the Invention

The basis of the invention is an objective of creating such a remotely controlled gyrostabilized operator crane, in which the boom has an inner part formed with the possibility of turning along the axis of the boom, connected with the drive of the inner part of the boom and hinge link, while the mechanism of parallelogram-type includes a driving and a driven block connected by a cable, a gyroscopic sensitive element of hinge link is introduced and mounted on it so that its measuring axis is parallel to the axis of the extension of the hinge link, the gyroscopic sensitive element of the inner part of the boom is arranged so that its measuring axis is parallel to the axis of the boom, the gyroscopic sensitive element of the boom is mounted on it so that its measuring axis is parallel to the axis of the extension of the boom, the

gyroscopic sensitive element of the vertical support is mounted on it so that its measuring axis is parallel to the axis of suspension of the vertical support relative to the base, longitudinal and vertical accelerometers are mounted on the hinge link so that their measuring axes and the axis of suspension of the hinge link are perpendicular, the transverse accelerometer is mounted on the inner part of the boom so that its measuring axis is parallel to the axis of suspension of the hinge link, electronic blocks of the hinge link and inner part of the boom, wherein the first input of the electronic block of the hinge link is connected with the output of the longitudinal accelerometer, the second input of the electronic block of the hinge link is connected with the output of the gyroscopic sensitive element of the hinge link, and the output of the electronic block of the hinge link is connected with the input of the drive of the hinge link, first input of the electronic block of the inner part of the boom is connected with the output of the transverse accelerometer, the second input of the electronic block of the inner part of the boom is connected with the output of the gyroscopic sensitive element of the inner part of the boom, the output of the electronic block of the inner part of the boom is connected with the input of the drive of the inner part of the boom, the first input of the electronic block of the vertical turning of the boom is connected with the output of the control board for vertical turning of the boom, the second input of the electronic block of the vertical turning of the boom is connected with the output of the gyroscopic sensitive element of the boom, the first input of the electronic block of the vertical turning of the boom

is connected with the output of the vertical accelerometer, and the output of the electronic block of the vertical turning of the boom is connected with the input of the vertical drive of the boom, the first input of the electronic block of the horizontal turning of the boom is connected with the output of the gyroscopic sensitive element of the vertical support, the second input of the electronic block of the horizontal turning of the boom is connected with the output of the control board for horizontal turning of the boom, the output of the electronic block of the horizontal turning of the boom is connected with the input of the drive of the vertical support, the vertical support of the boom, the drive of the inner part of the boom and the hinge link are mounted in a tail part of the boom and form a counterweight, to provide kinematic insulation of the hinge unit with the movie-television shooting equipment mounted on it from all angular vibrations of the carrier, its angular movements practically do not affect the movement of the shooting equipment, determined by the signals from the control board for controlling the crane, kinematic insulation of the boom from angular vibrations of the carrier around the vertical axis and the axis of suspension of the boom which during movement of the carrier makes possible to substantially reduce loads on it from the side of the base of the crane.

Automation of the control process of the boom provides for a compensation of vertical rectilinear vibrations of the carrier in the point of mounting of the movie and television shooting equipment. As a result, the shooting equipment maintains its orientation regardless of the movement of the carrier and because

of this makes possible to obtain stable qualitative horizontal representation of the object which is shoot statically or in movement, and also to expand creative possibilities of the operator.

The above objective is solved in that, in the remotely controlled gyrostabilized operator crane comprising known features: a boom mounted on a vertical support with the possibility of a vertical turning and connected with the vertical drive of the boom, with the vertical support mounted on the base with the possibility of horizontal turning and connected with the drive of the vertical support, a hinge link for placing movie and television equipment mounted on the end of the boom with the possibility of turning around a horizontal axis of the suspension of the hinge link, perpendicular to the axis of the boom, connected with the drive of the hinge link by a mechanism of parallelogram-type mounted in the tail part, a counterweight mounted in a tail part, a control board and electronic blocks for vertical and horizontal turning of the boom, with the following distinguishing features which are sufficient in all cases and for which the legal protection is requested: the boom has an inner part formed with the possibility of turning along the axis of the boom, connected with the drive of the inner part of the boom and the hinge link and features which characterize the invention only in specific cases: the mechanism of the parallelogram-type composed of a driving and a driven block connected by a cable, a gyroscopic sensitive element for the hinge link mounted on it so that its measuring axis is

parallel to the axis of suspension on the hinge link, a gyroscopic sensitive element of the inner part of the boom mounted on it so that its measuring axis is parallel to the axis of the boom, a gyroscopic sensitive element of the boom mounted on it so that its measuring axis is parallel to the axis of suspension of the boom, a gyroscopic sensitive element of a vertical support mounted on it so that its measuring axis is parallel to the axis of suspension of the vertical support relative to the base, longitudinal and vertical accelerometers mounted on the hinge link so that their measuring axes and the axis of suspension of the hinge link are mutually perpendicular, the transverse accelerometer mounted on the inner part of the boom so that its measuring axis is parallel to the axis of suspension of the hinge link, electronic blocks of the hinge link and the inner part of the boom, wherein the first input of the electronic block of the hinge link is connected with the output of the longitudinal accelerometer, the second input of the electronic block of the hinge link is connected with the output of the gyroscopic sensitive element of the hinge link, the output of the electronic block of hinge link is connected with the input of the drive of hinge link, the first input of the electronic block of the third part of the boom is connected with the output of the transverse accelerometer, the second input of the electronic block of the inner part of the boom is connected with the output of the gyroscopic sensitive element of the inner part of the boom, the output of the electronic block of the inner part of the boom is connected with the input of the drive of the inner part of the boom, the first input of the electronic block of the vertical turning of the

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boom is connected with the output of the control board for vertical turning of the boom, the second input of the electronic block of the vertical turning of the boom is connected with the output of the gyroscopic element of the boom, the third input of the electronic block for the vertical turning of the boom is connected with the output of the vertical accelerometer, the output of the electronic block of the vertical turning of the boom is connected with the input of the vertical drive of the boom, the first input of the electronic block for the horizontal turning of the boom is connected with the output of the gyroscopic sensitive element of the vertical support, the second input of the electronic block for the horizontal turning of the boom is connected with the output of the control board for horizontal turning of the boom, the output of the electronic block of the horizontal turning of the boom is connected with the input of the drive of the vertical support, the vertical drive of the boom, the drive of the inner part of the boom and the hinge link are mounted in the tail part of the boom and perform the function of a counterweight.

Because of the use in the proposed remotely controlled gyrostabilized operator crane of the boom, containing the inner part formed with the possibility of turning along the axis of the boom, connected with the drive of the inner part of the boom, the boom mounted on the vertical support with the possibility of vertical turning and connected with the vertical drive of the boom, the vertical support mounted on the base with the possibility of the horizontal

turning, connected with the horizontal drive of the vertical support, the hinge link for placing the movie and television equipment, mounted on the end of the inner part of the boom with the possibility of turning around the horizontal axis of the suspension of the hinge link, perpendicular to the axis of the boom, the mechanism of the parallelogram-type connected with the drive of the hinge link and composed of a driven and driving block connected by a cable, mounted in the tail part of the boom the vertical drive of the boom, the drives of the inner part of the boom, and the hinge link performing the functions of the counterweight, the control board and electronic blocks of vertical and horizontal turning of the boom, introduction of the gyroscopic sensitive element of the hinge link mounted on it so that its measuring axis is parallel to the axis of suspension of the hinge link, gyroscopic sensitive element of the inner part of the boom mounted on it so that its measuring axis is parallel to the axis of the boom, gyroscopic sensitive element of the boom mounted on it so that its measuring axis is parallel to the axis of suspension of the boom, gyroscopic sensitive element of the vertical support mounted on it so that its measuring axis is parallel to the axis of suspension of the vertical support relative to the base, longitudinal and vertical accelerometers mounted on the hinge link so that their measuring axes and the axis of suspension of the hinge link are mutually perpendicular, a transverse accelerometer mounted on the inner part of the boom so that its measuring axis is parallel to the axis of suspension of the hinge link, electronic blocks of hinge link and the inner part of the boom, connection

Fig. 3. *Amphibolite*

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of the first input of the electronic block of the hinge link with the output of the longitudinal accelerometer, the second input of the electronic block of hinge link with the output of the gyroscopic sensitive element of the hinge link, the output of the electronic block of the hinge link with the input of the drive of the hinge link, connection of the first input of the electronic block of the inner part of the boom with the output of the transverse accelerometer, the second input of the electronic block of the inner part of the boom with the output of the gyroscopic sensitive element of the inner part of the boom, the output of the electronic block of the inner part of the boom with the input of the drive of the inner part of the boom, connection with the first input of the electronic block for the vertical turning of the boom with the output of the control board for the vertical turning of the boom, the second input of the electronic block of the vertical turning of the boom with the output of the gyroscopic sensitive element of the boom, the first input of the electronic block of the vertical turning of the boom, with the output of the vertical accelerometer, the output of the electronic block of the vertical turning of the boom with the input of the vertical drive of the boom, connection of the first input of the electronic block of the horizontal turning of the boom with the output of the gyroscopic sensitive element of the vertical support, the second input of the electronic block of the horizontal turning of the boom with the output of the control board for the horizontal turning of the boom, the output of the electronic block of the horizontal turning of the boom with the input of the drive of the vertical support, there are provided a four-axes

gyrostabilization for the proposed construction of the movie operator crane, or in other words its hinge unit with the movie and television shooting equipment, the boom, its inner part and the vertical support, substantial simplifications and weight reduction of the construction and because of this obtaining of stable and qualitative image with ensuring of a horizontal frame, as well as substantial expansion of operator possibilities.

The invention is illustrated by a diagram.

Short Description of Diagram

Electronic-kinematic diagram of the remotely controlled gyrostabilized operator crane is shown in Figure 1.

The remotely controlled gyrostabilized operator crane contains a boom 1 composed of an inner part 2 formed with the possibility of turning in bearings 3, 4 along the axis of the boom 5, connected with the drive of the inner part of the boom 6. The boom 1 is mounted on the vertical support 7 with the possibility of the vertical turning in the bearings 8, 9 around the axis of the boom 10 and connected with the vertical drive of the boom 11, wherein the vertical support 7 is mounted on the base 12 arranged on the carrier 13 with the possibility of horizontal turning in the bearing 14 around the axis of suspension

of the vertical support 15 and connected with the drive of the vertical support 16. The hinge link 17 for placing a movie and television shooting equipment 18 mounted on the end of the inner part of the boom 2 with the possibility of turning around the axis of suspension of the hinge link 19 in the bearing 20 perpendicular to the axis of the boom 5, connected with the drive of the hinge link 21 by a mechanism of a parallelogram-type 22 composed of a driving and driven blocks 23, 24 connected by a cable 25 mounted in the tail part of the inner part of the boom 2, a vertical drive of the boom 11, drives of inner parts of the boom 6 of the hinge link 17 mounted in the tail part of the inner part of the boom 2 performed partially the function of the counterweight 6.

The gyroscopic sensitive element of the hinge link 27 is mounted on the hinge link 17 so that its measuring axis is parallel to horizontal axis of the suspension of the hinge link 19, the longitudinal and vertical accelerometer 28, 29 are mounted on the hinge link 17 so that their measuring axes and the axes of the suspension of the hinge link 19 are mutually perpendicular, the gyroscopic sensitive element of the inner part of the boom 30 mounted on the inner part of the boom 2 so that its measuring axis is parallel to the axis of the boom 5, the transverse accelerometer 21 mounted on the inner part of the boom 2 so that its measuring axis is parallel to the axis of suspension of the hinge link 19, the gyroscopic sensitive element of the boom 32 mounted so that its measuring axis is parallel to the axis of the suspension of the boom 10, the

gyroscopic sensitive element of the vertical support 33 mounted on the vertical support 7 so that its measuring axis is parallel to the axis of suspension of the vertical support 15.

The control board 34 provided for forming in the first output 35 of a signal for controlling the horizontal turning of the boom around an axis of suspension of the vertical support 15 and in the second output 36 of a signal for controlling of the vertical turning of the boom around the axis of suspension of the boom 10.

The electronic block for horizontal turning of the boom 37 has two inputs, the first input 38 is connected with the output of the gyroscopic sensitive element of the vertical support 33, the second input 39 is connected with the output of the control board 35, and the output is connected with the drive of the vertical support 16.

The electronic block of the vertical turning of the boom 40 has three inputs, the first input 41 is connected with the second output of the control board for the vertical turning of the boom 36, the second input 42 is connected with the output of the gyroscopic sensitive element of the boom 32, the third input 43 is connected with the output of the vertical accelerometer 29, and the output is connected with the input of the vertical drive of the boom 11.

The electronic block of the inner part of the boom 44 has two inputs, the first input 45 is connected with the output of the transverse accelerometer 31, the second input 46 is connected with the output of the gyroscopic sensitive element of the inner part of the boom 30, and the output is connected with the drive of the inner part of the boom 36.

The electronic block of the hinge link 47 has two inputs, the first input 48 is connected with the output of the longitudinal accelerometer 28, the second input 49 is connected with the output of the gyroscopic sensitive element of the hinge link 27, and the output is connected with the input of the drive of the hinge link 21.

The remotely controlled gyrostabilized operator crane operates in the following manner.

When there are no signals from the control board 34, the possibility of turning of the movie and television shooting equipment 8 and the elements of the construction of the crane exists only as a result of action on them by external disturbing movements, for example friction in the bearings and drives, disbalance, aerodynamic forces, stretching of current conductors, etc. Therefore for stabilization of the position of the hinge link 17 and the shooting equipment 18 arranged on it, it is necessary that, by means of the

gyroscopic sensitive elements 32, 27, 30, 31 of the boom 1, the hinge link 27, the inner part of the boom 30, the vertical support 33, the electronic block of the horizontal and vertical turning of the boom 37, 40, the inner part of the boom 44, the hinge link 47 and the drives 16, 11, 6, 21, to apply to corresponding elements of the crane the moments which compensate the above listed outer disturbing moments.

With the action on the hinge link 13 of the moment of outer surface around the axis of suspension of the hinge link 19, the gyroscopic sensitive element of the hinge link 27 generates a signal which is supplied to the second input of the electronic block of the hinge link 49. This signal is amplified by this block, and from its outlet is supplied to the input of the drive of the hinge link 21. The obtained moment, by means of the mechanism of the parallelogram type 22 containing the driving block 23, the cable 25, and the driven block 24, is transmitted to the hinge link 17 and compensates the moment of the outlet forces, so as to provide the immovability of the movie and television equipment 18.

With the action on the hinge link 17 of the moment of outer forces around the axis of the boom 5, it is transmitted through the bearing 20 to the inner part of the boom, the gyroscopic sensitive element of the inner part of the boom 30 generates a signal which is supplied to the second input of the

electronic block of the inner part of the boom 46. This signal is amplified by this block, and from its output is supplied to the input of the drive of the inner part of the boom 6. The obtained moment, through the bearing 20, is supplied through the hinge link 17 and compensates the moment of the outer forces, so as to prevent the change of the position of the hinge link 17 in the space around the axis of suspension of the inner part of the boom 5 so as to provide the immovability of the movie and television shooting equipment 18.

With the action of the moment of the outer forces on the boom 1 around the axis 10, the gyroscopic sensitive element of the boom 32 generates a signal which is supplied to the second input 42 of the electronic block for the vertical turning of the boom 40. This signal is amplified by this block, and from its output is supplied to the input of the vertical drive of the boom 11. The moment generated by the drive 11 compensates the moment of the outer forces, so as to prevent vibration of the boom 1 around the axis 10.

With the action of the moment of outer forces on the boom 1 around the axis 15, it is transmitted through the bearings 8, 9 to the vertical support 7. The gyroscopic sensitive element of the boom 33 generates the signal which is supplied to the first input 38 of the electronic block of the horizontal turning of the boom 37. This signal is amplified by this block, and from its output is supplied to the input of the drive of the vertical support 16.

The moment generated by the drive compensates the moment of the outer forces so as to prevent vibrations of the boom 1 around the axis 18.

Therefore, in the absence of signals from the control board 34, the moments of the outer forces applied to the movie shooting equipment 18 around the axes 5 and 19, and also to the boom around the axes 10 and 15 are compensated which allows to exclude vibrations of the shooting equipment 18 and the boom 1.

With the supply from the second output 36 of the control board 34 of a signal for controlling the boom 1 around the axis 10 to the first input 41 of the electronic block for the vertical turning of the boom 40, it is added to the output signal of the gyroscopic sensitive element of the boom 32 supplied to the first input of the electronic block 40.

As a result, in the block 40 a signal is formed which corresponds to the turning of the coordinate system, modeled by the gyroscopic sensitive element of the boom 32. This signal is supplied to the input of the vertical drive of the boom 11, which turns the boom 1 around the axis of suspension of the boom 10 in exact correspondence to the signal and to the first output 36 of the control board 34.

With the supply from the first output 35 of the control board 34 of the signal for controlling of the boom 1 around the axis 15 to the second input 39 of the electronic block of the horizontal turning of the booms 37, it is added to the output signal of the gyroscopic sensitive element of the vertical support 33 supplied to the first input 38 of the above mentioned electronic block. As a result, at the output of this block 37 a signal is formed which corresponds to the turning of the coordinate system modeled by the gyroscopic sensitive element of the vertical support 33. This signal is supplied to the input of the drive of the vertical support 16, which turns the boom 1 around the axis 15 in exact correspondence with the signal and the first output 35 of the control board 34.

The inaccuracies of the gyroscopic sensitive element of the inner part of the boom 30, the electronic block of the inner part of the boom 44, and also outer disturbing moments applied to the hinge link 17 and the inner part of the boom 2 around the axis of the boom 5 during a long time interval can cause its turning around this axis. In order to exclude this turning, the transverse accelerometer 31 is arranged and measures the deviation of the axis of the suspension of the hinge link 19 from the surface of the horizon. From the output, the signal is supplied to the first input 45 of the electronic block of the inner part of the boom 44 and is added to the signal at the second input 46 of the block 44 so as to cause turning of the coordinate system modeled by the gyroscopic sensitive element of the inner part of the boom 30 toward the side

which is opposite to the deviation of the axis of suspension of the hinge link 19 from the plane of horizon. At the output of the electronic block of the inner part of the boom 44, a signal is formed which is supplied to the input of the drive of the inner part of the boom 44, which turns it and the axis of suspension of the hinge link 19 to the plane of horizon.

Inaccuracies of the gyroscopic sensitive element of the hinge link

27, the electronic block of the hinge link 47 and also outer disturbing moments applied to the shooting equipment 18 and hinge link 17 around its hinge link 19 over a long time interval can cause turning of these elements around the axis 19. For excluding this turning, a longitudinal accelerometer 28 is arranged and measures the deviation of the hinge link 17 from the plane of horizon around the axis of suspension of the hinge link 19. With the mentioned deviation the signal from the input of the longitudinal accelerometer 28 is supplied to a first input 48 of the electronic block of the hinge link 47 and is added to the signal of the second input 49 of the gyroscopic sensitive element of the hinge link 27 so as to cause turning of the coordinate system modeled by this sensitive element toward the side which is opposite to the deviation of the hinge link 17 from the plane of horizon. At the output of the electronic block of the hinge link 47 a signal is formed which is supplied to the input of the drive of the hinge link 21, which by the mechanism of parallelogram type 22 containing the driving

block 23, the driven block 24 and by means of the cable 25, turn the hinge link 17 to the plane of horizon.

Application of vertical forces of the hinge link 17 or to the shooting equipment 18 at the output of the vertical accelerometer 29 causes a signal which, after amplification by the electronic block of the vertical turning of the boom 40, is supplied to the vertical drive of the boom 11. As a result of the action of this drive in the point of mounting of the hinge link 17 and the shooting equipment 18 a force is created which compensates the above mentioned vertical forces. Therefore, along the vertical axis the vibration of the shooting equipment 18 are excluded.

Therefore, the proposed construction of the crane and the system of automatic control of its movement makes possible to provide a space stabilization of the position of shooting equipment, to increase the accuracy of control of its movement, which in turn provides a stability and high quality of the obtained image and horizontality of the frame with the use of any panoramic heads.

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